Preliminary Observations on the Effects of Using Clam Shells for Acid Rain Mitigation in Maine Salmon Streams

Mark Whiting, Biologist,
Salmon Rivers Program

Acidity Sources in Maine Streams

- High Dissolved Organic Carbon (DOC)
- High carbon dioxide
- Dilution of alkalinity during high flows
- Bedrock geology, slow weathering & nutrient poor
- 100 years of acid rain
- Recent partial recovery due to Clean Air Act (1970) (1990)
- 200 years of forest harvests
- Recovery (regrowth) of forests

Acid Rain (etc.) Is Inhibiting Salmon Recovery in Eastern Maine

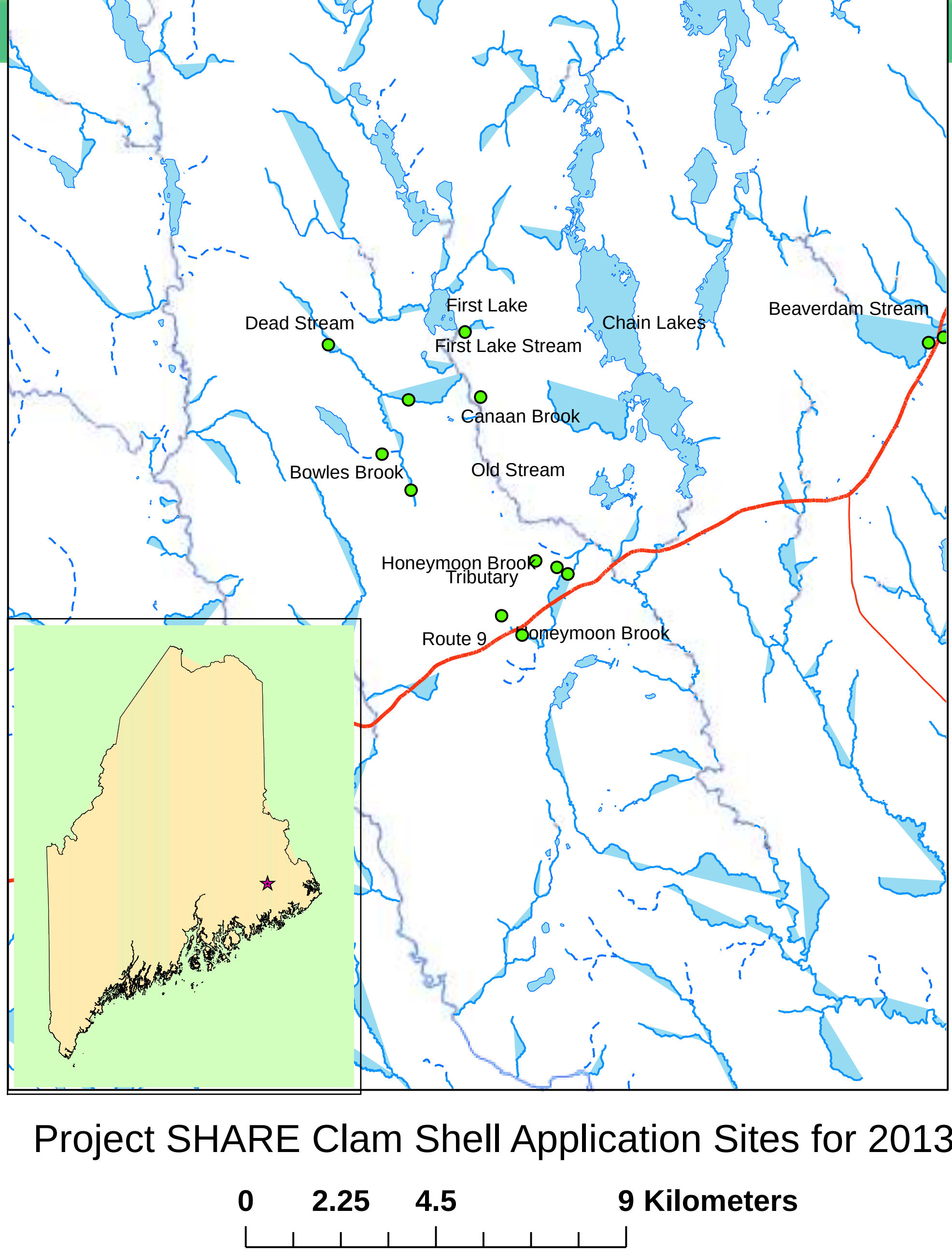
- These rivers are: Narraguagus, Pleasant, Machias, East Machias & Denny's Rivers
- Terry Haines reported "self-sustaining populations" of Atlantic salmon in 1984, these are long gone
- Today, we stock millions of hatchery fish each year and get few returns

Why Use Shells?

- SHARE is liming streams with shells as a calcium carbonate source
- Our purpose is to restore salmon, brook trout and other species
- This is an ecosystem approach that should result in greater biodiversity and improved ecosystem integrity


Albert Caver Inc, Great Wass Island 1/1/2009


Bowles Brook with mahogany clam shells

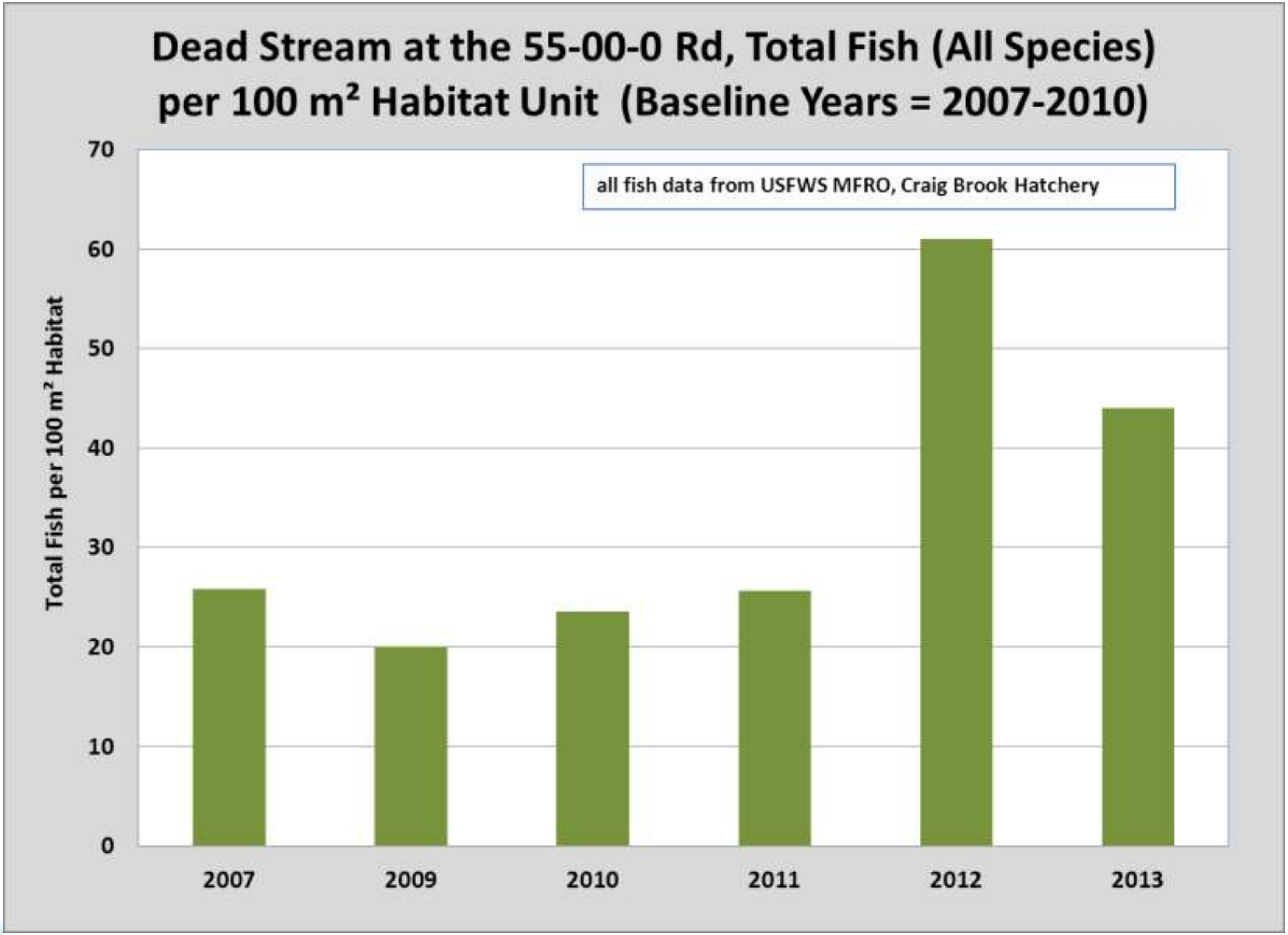


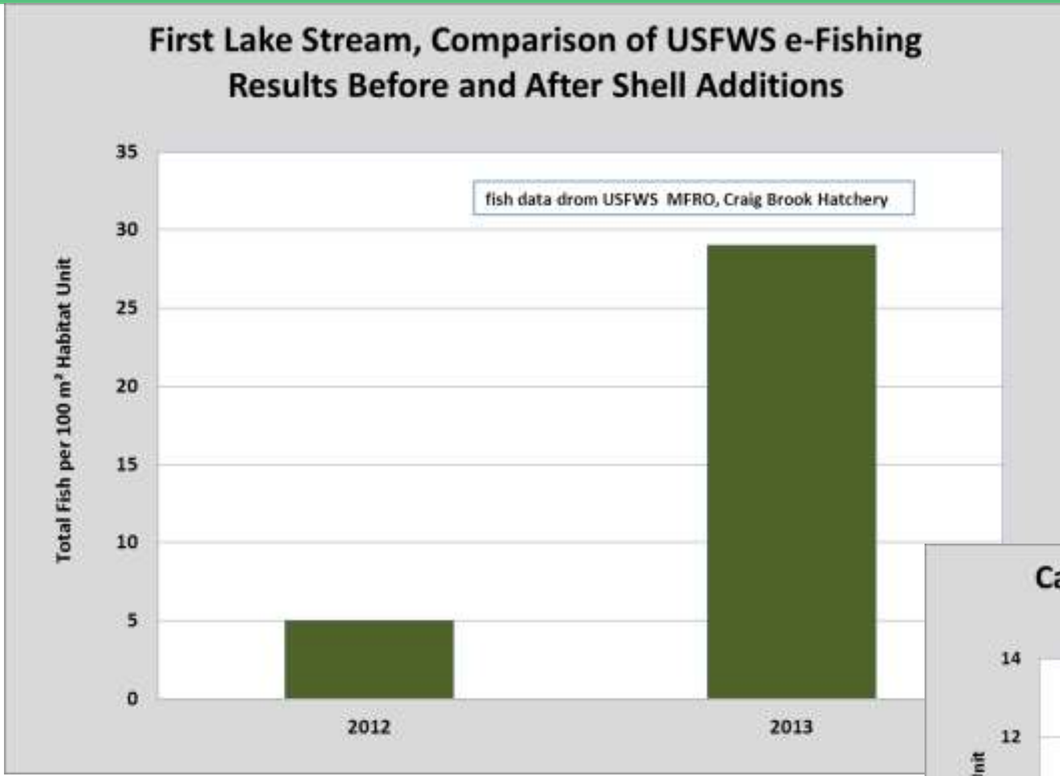
Project SHARE Clam Shell Application Sites for 2013

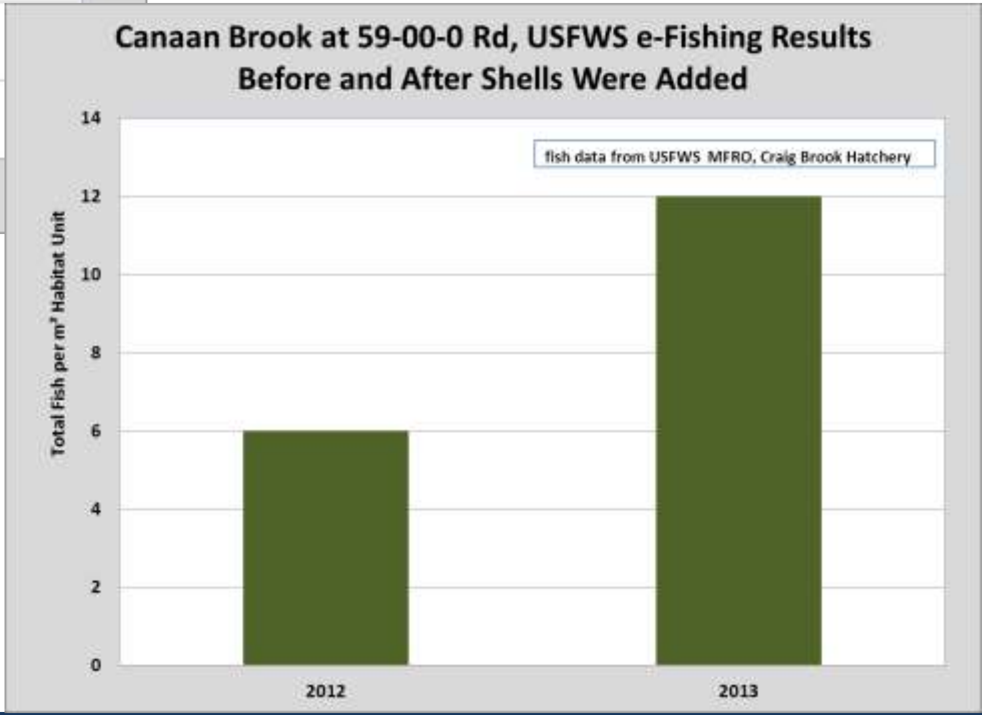
Dead Stream Lab Chemistry Results 2012

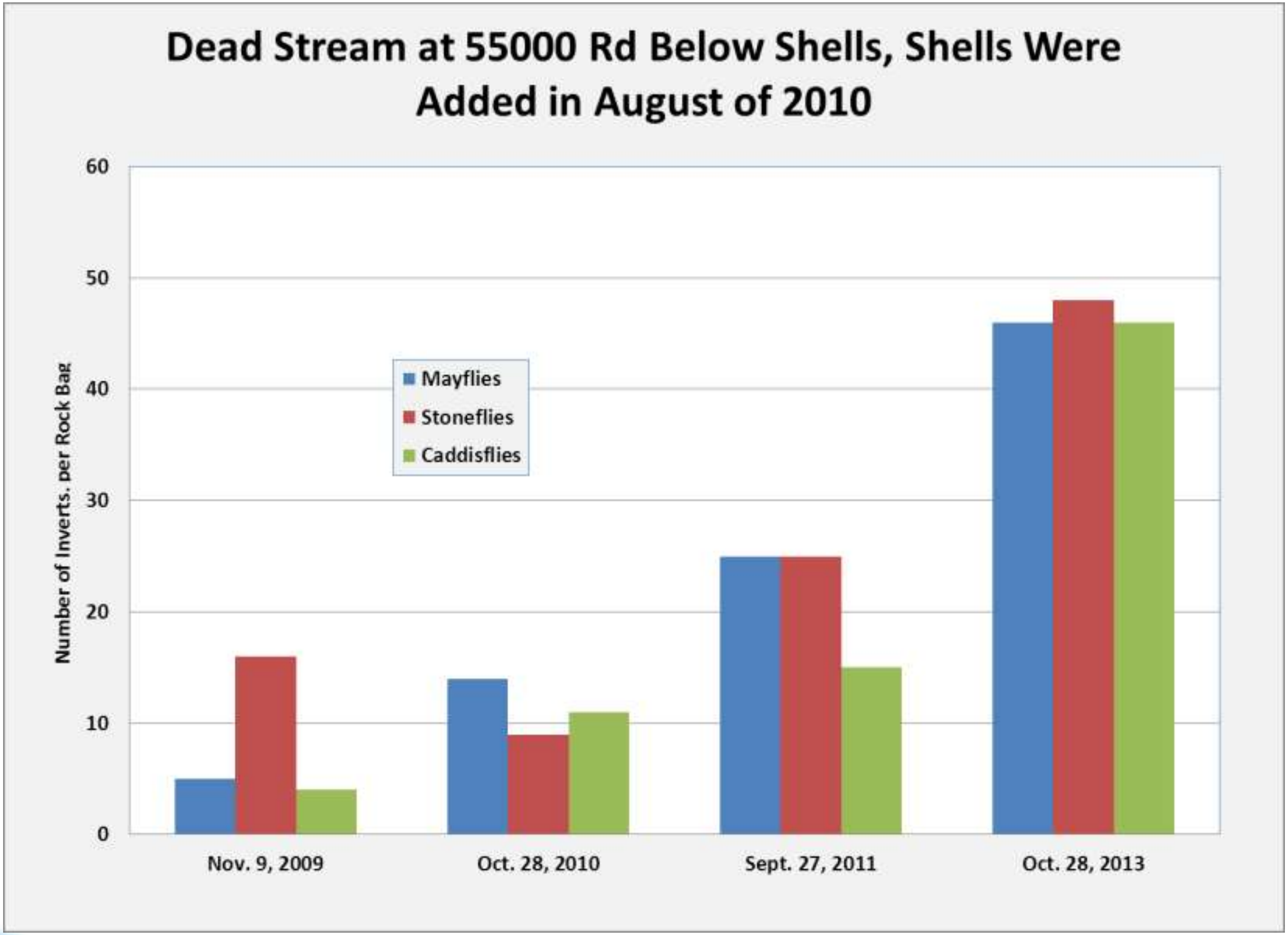
	Date	Flow Type	Relative Depth	ANC ueq/L	pH	Ca mg/L	Al x ug/L
Dead Stream Upstream	6/19/12	Baseflow	Low	119	5.99	1.99	20
Dead Stream Downstream	6/19/12	Baseflow	Low	277	7.02	3.06	9
Dead Stream Farther Downstream	6/19/12	Baseflow	Low	162	6.71	2.13	21
Dead Stream Upstream	8/27/12	Baseflow	Low	161	6.03	3.14	36
Dead Stream Downstream	8/27/12	Baseflow	Low	306	7.07	5.46	12
Dead Stream Farther Downstream	8/27/12	Baseflow	Low	299	6.99	3.81	9
Dead Stream Upstream	10/11/12	Storm flow	High	84	5.55	2.67	31
Dead Stream Downstream	10/11/12	Storm flow	High	120	6.02	3.26	39
Dead Stream Farther Downstream	10/11/12	Storm flow	High	72	5.55	2.47	26

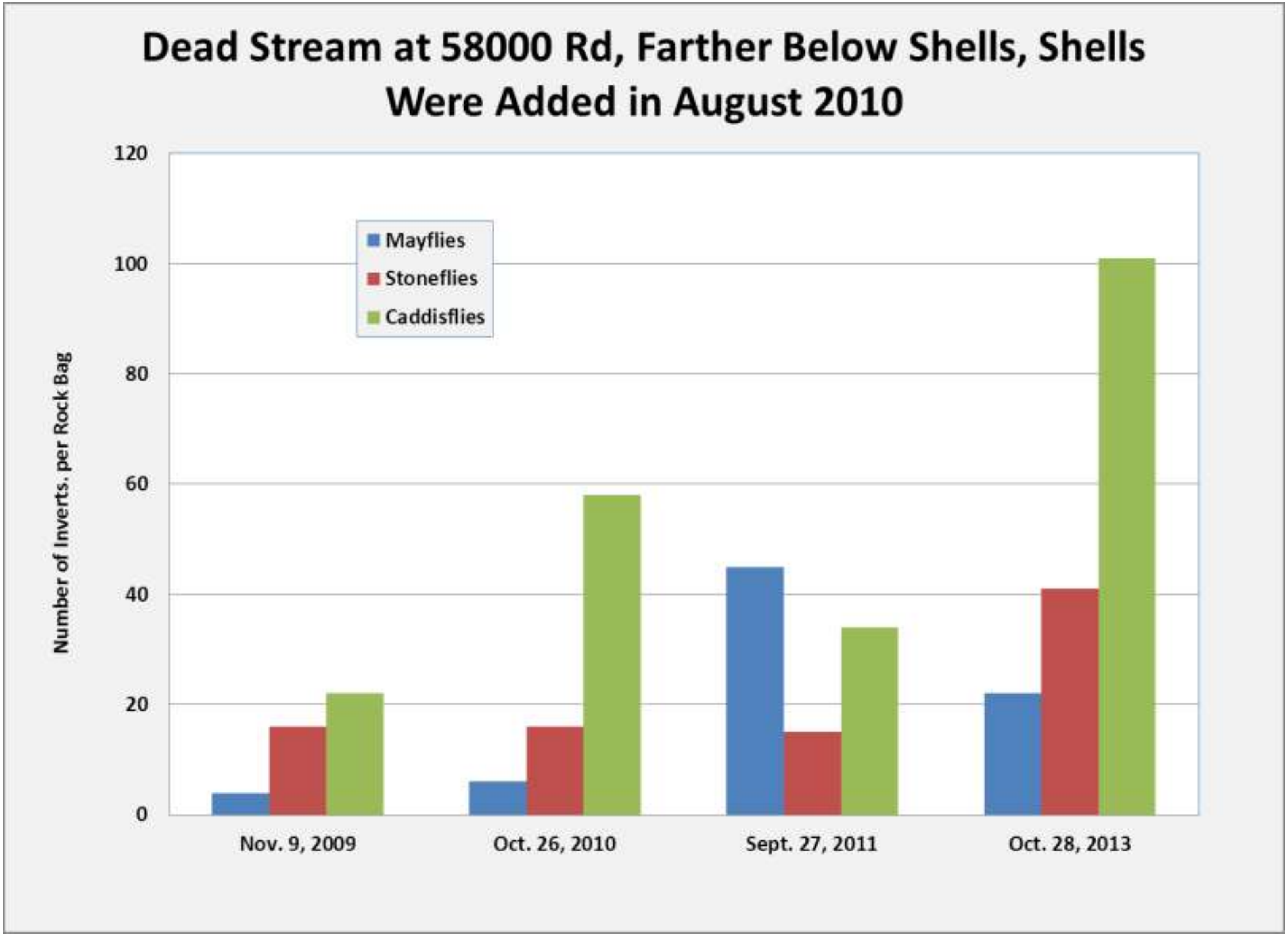
Lab data from U of Maine, Sawyer Environmental Chemistry & Research Lab


Dead Stream at the 55-00-0 Rd, Total Fish (All Species) per 100 m² Habitat Unit (Baseline Years = 2007-2010)
all fish data from USFWS MFRO, Craig Brook Hatchery
Total Fish per 100 m² Habitat
0
10
20
30
40
50
60
70
2007
2009
2010
2011
2012
2013


First Lake Stream, Comparison of USFWS e-Fishing Results Before and After Shell Additions
fish data drom USFWS MFRO, Craig Brook Hatchery
Total Fish per 100 m³ Habitat Unit
35
30
25
20
15
10
5
0
2012
2013


Canaan Brook at 59-00-0 Rd, USFWS e-Fishing Results Before and After Shells Were Added
fish data from USFWS MFRO, Craig Brook Hatchery
Total Fish per m³ Habitat Unit
14
12
10
8
6
4
2
0
2012
2013


Dead Stream at 55000 Rd Below Shells, Shells Were Added in August of 2010
Number of Inverts. per Rock Bag
60
50
40
30
20
10
0
Mayflies
Stoneflies
Caddisflies
Nov. 9, 2009
Oct. 28, 2010
Sept. 27, 2011
Oct. 28, 2013


Dead Stream at 58000 Rd, Farther Below Shells, Shells Were Added in August 2010
Mayflies
Stoneflies
Caddisflies
Number of Inverts. per Rock Bag
0
20
40
60
80
100
120
Nov. 9, 2009
Oct. 26, 2010
Sept. 27, 2011
Oct. 28, 2013

Leafpack Decomposition Using Exponential Decay Model (k = slope)

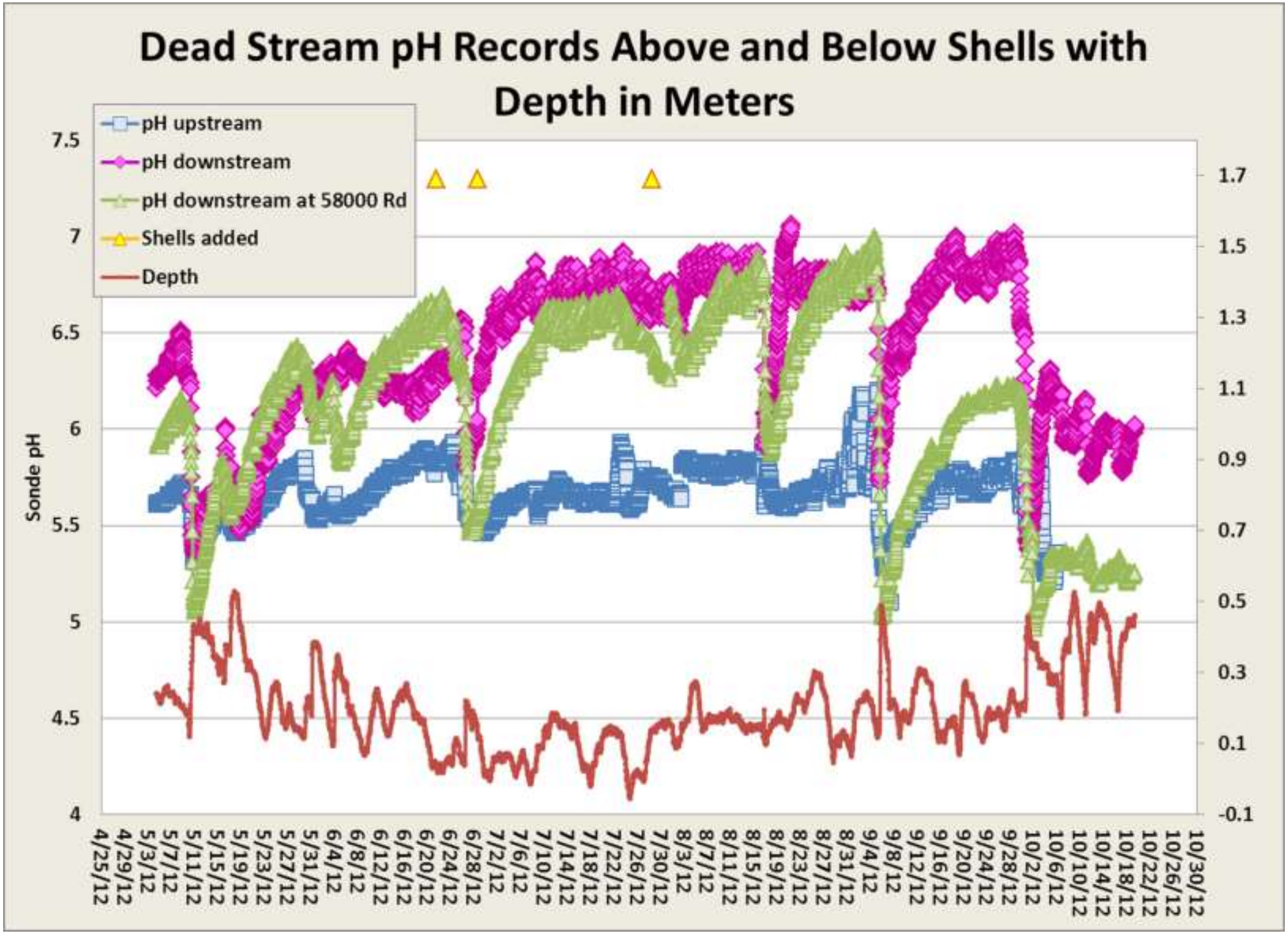
	- k	% loss/day
Dead - Not Treated (fast)	0.012	1.16
Dead - Not Treated (slow)	0.006	0.62
Dead - Treated (fast)	0.020	2.02
Dead - Treated (slow)	0.017	1.73
Honeymoon - Not Treated (fast)	0.012	1.25
Honeymoon - Not Treated (slow)	0.011	1.09

* k values are signif different at $p=0.024$ $df=4$ for treatment and non-treatment sites

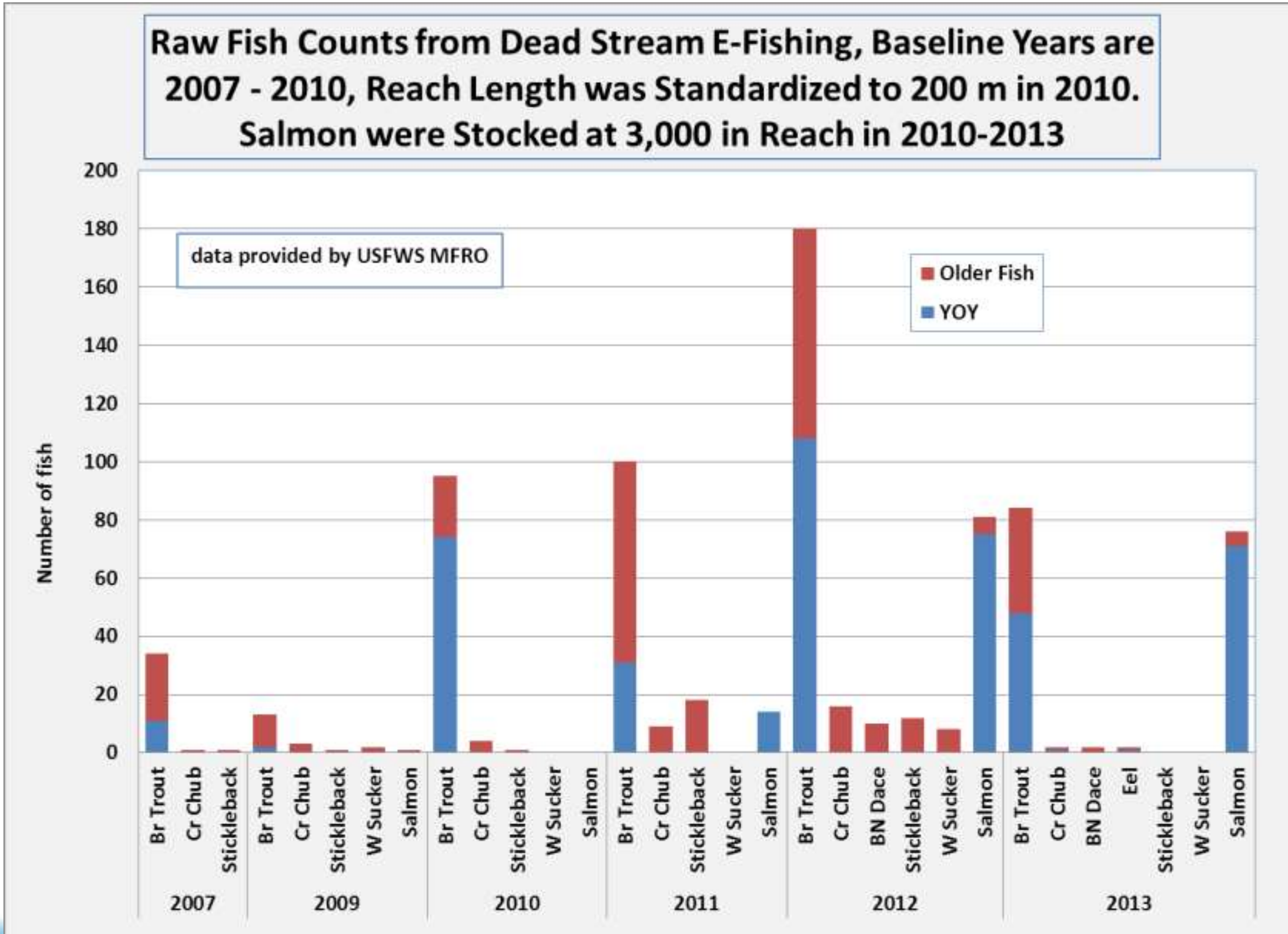
Summary

- These streams appear to be impaired
- Treatments have improved water chemistry, esp. baseflows
- Fish, microbes and macroinvertebrates have benefitted
- Detrital food chains appear to have improved
- But we need better high flow treatment
- Many more streams need help

www.maine.gov/dep



Dead Stream pH Records Above and Below Shells with Depth in Meters
pH upstream
pH downstream
pH downstream at 58000 Rd
Shells added
Depth
Sonde pH
7.5
7
6.5
6
5.5
5
4.5
4
1.7
1.5
1.3
1.1
0.9
0.7
0.5
0.3
0.1
-0.1
4/25/12
4/29/12
5/3/12
5/7/12
5/11/12
5/15/12
5/19/12
5/23/12
5/27/12
5/31/12
6/4/12
6/8/12
6/12/12
6/16/12
6/20/12
6/24/12
6/28/12
7/2/12
7/6/12
7/10/12
7/14/12
7/18/12
7/22/12
7/26/12
7/30/12
8/3/12
8/7/12
8/11/12
8/15/12
8/19/12
8/23/12
8/27/12
8/31/12
9/4/12
9/8/12
9/12/12
9/16/12
9/20/12
9/24/12
9/28/12
10/2/12
10/6/12
10/10/12
10/14/12
10/18/12
10/22/12
10/26/12
10/30/12


Raw Fish Counts from Dead Stream E-Fishing, Baseline Years are 2007 - 2010, Reach Length was Standardized to 200 m in 2010. Salmon were Stocked at 3,000 in Reach in 2010-2013
data provided by USFWS MFRO
Older Fish
YOY
Number of fish
200
180
160
140
120
100
80
60
40
20
0
Br Trout
Cr Chub
Stickleback
W Sucker
Salmon
BN Dace
Eel
2007
2009
2010
2011
2012
2013

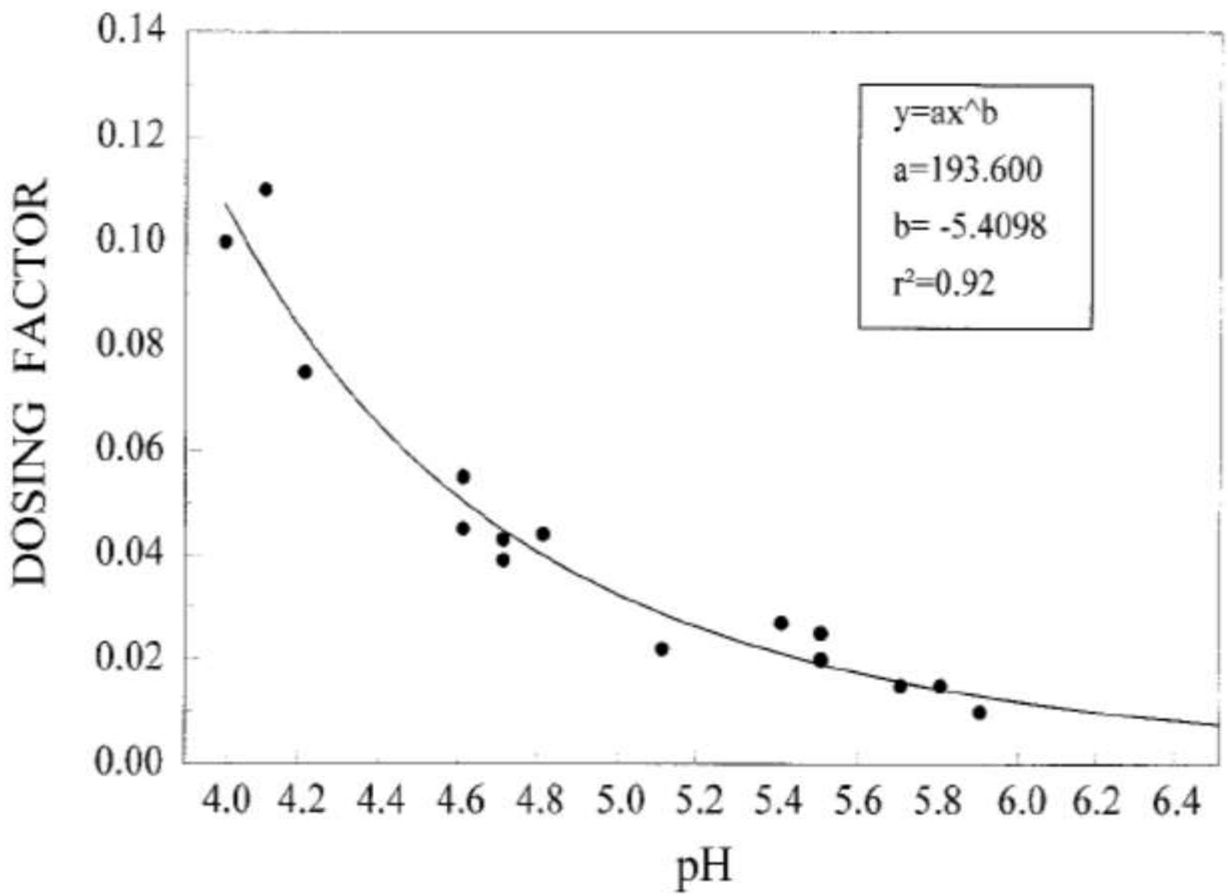
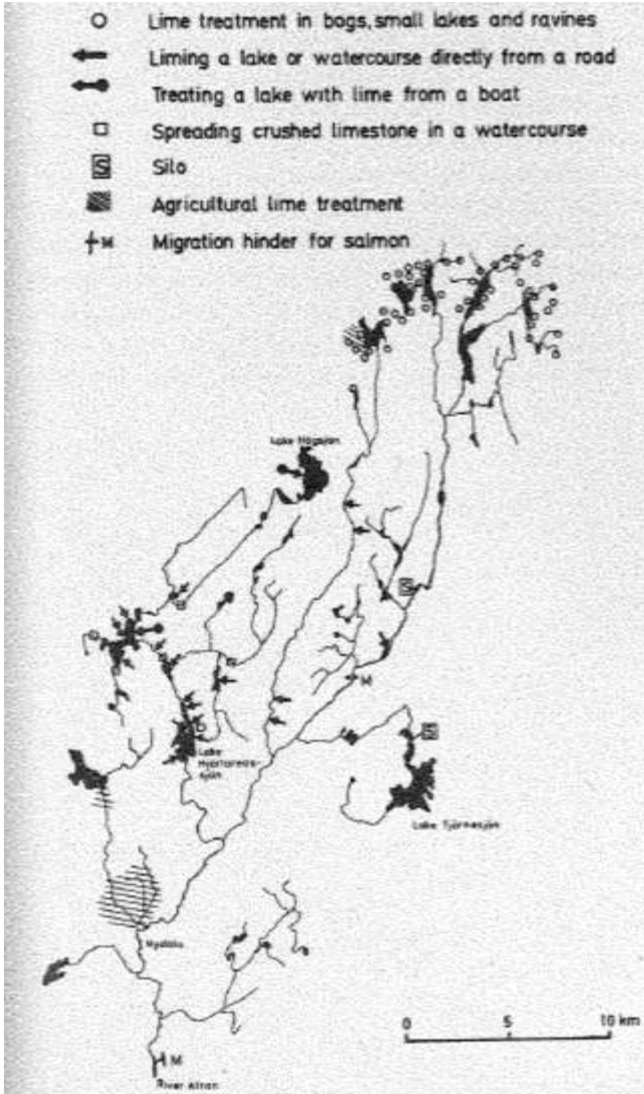
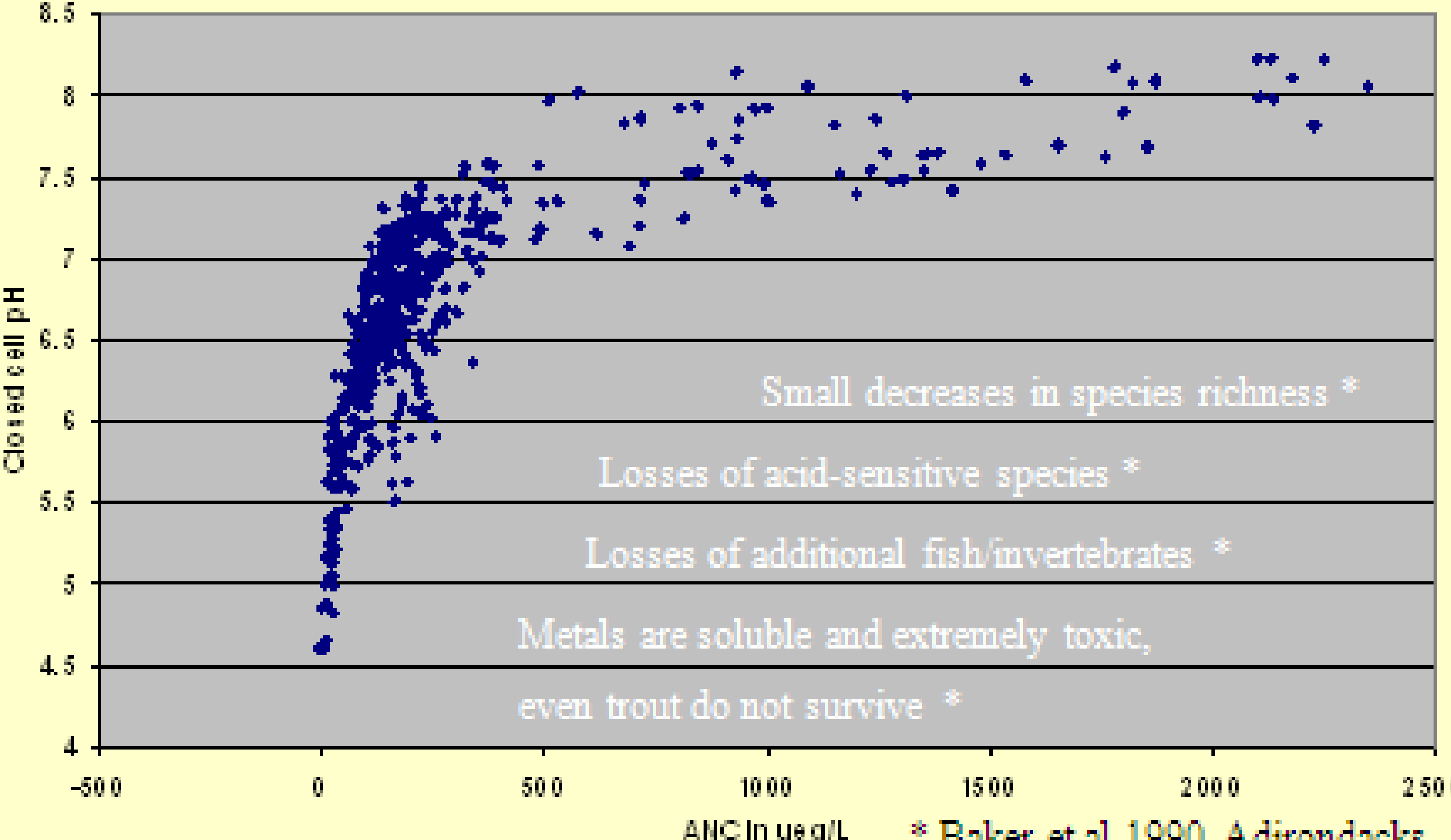


FIGURE 3.—Relation between limestone dosing factor and pH for West Virginia streams. The dosing factor is multiplied by the watershed area (ha) of the stream to estimate the amount of limestone needed (metric tons) to neutralize the acidity. Treatment amounts in the initial year should be twice the annual amount needed.



ure 4 Liming activities within the project.

Maine DEP Salmon Rivers pH vs ANC



* Baker et al 1990, Adirondacks

What Do Artificially Acidified Streams Look Like?

- Chronically or episodically acidic (below pH 6)
- Large swings in pH over short periods
- Impaired communities
- Low Ca (below 4 mg/L)
- Toxic levels of free ionic Al (above 25 µg/L)
- Characteristic fish gill pathologies and fish kills
- High P
- Low productivity (not P-limited)
- Specific indicator taxa are present or absent
- Loss of biodiversity, species and even Orders & sometimes Phyla may be missing